Improving GCM Projections of Regional Rainfall Change using NASA PMM Observations

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2017 PMM Science Team Meeting

Outline

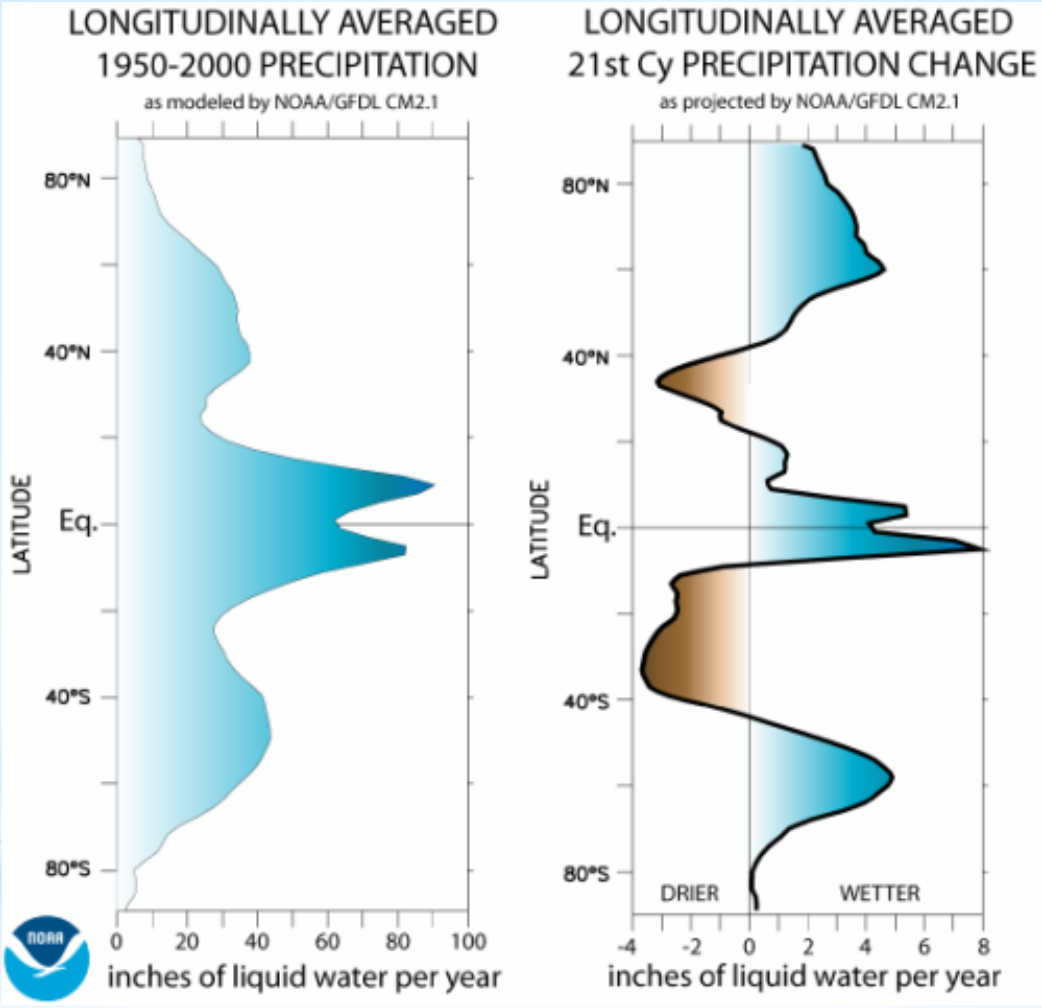
Goal: Develop methods for using satellite rainfall observations to improve model projections of regional rainfall change.

i) What processes are responsible for intermodel differences in projections of future rainfall change at regional scales?

ii) How do biases in the mean climate influence projections of future change?

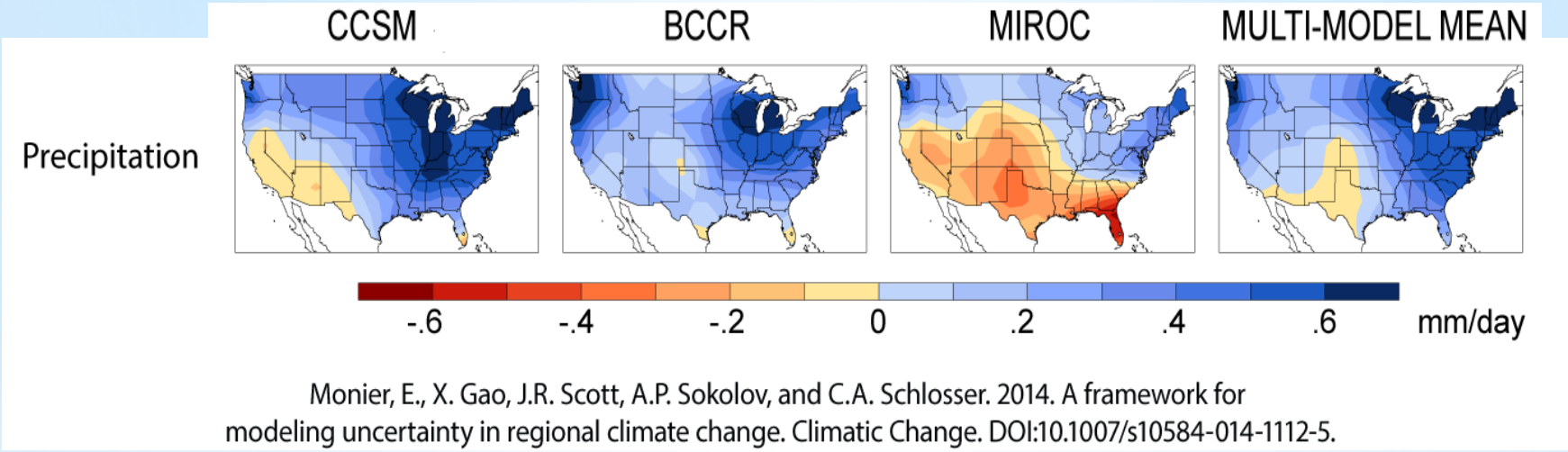
iii) What are the consequences of constraining model projections using observed precipitation climatology?

Model Projections Global Precipitation Change



At global scale, increased water vapor determines pattern of precipitation change.
"Wet get wetter, dry get drier"

Model Projections Regional Precipitation Change



Monier, E., X. Gao, J.R. Scott, A.P. Sokolov, and C.A. Schlosser. 2014. A framework for modeling uncertainty in regional climate change. Climatic Change. DOI:10.1007/s10584-014-1112-5.

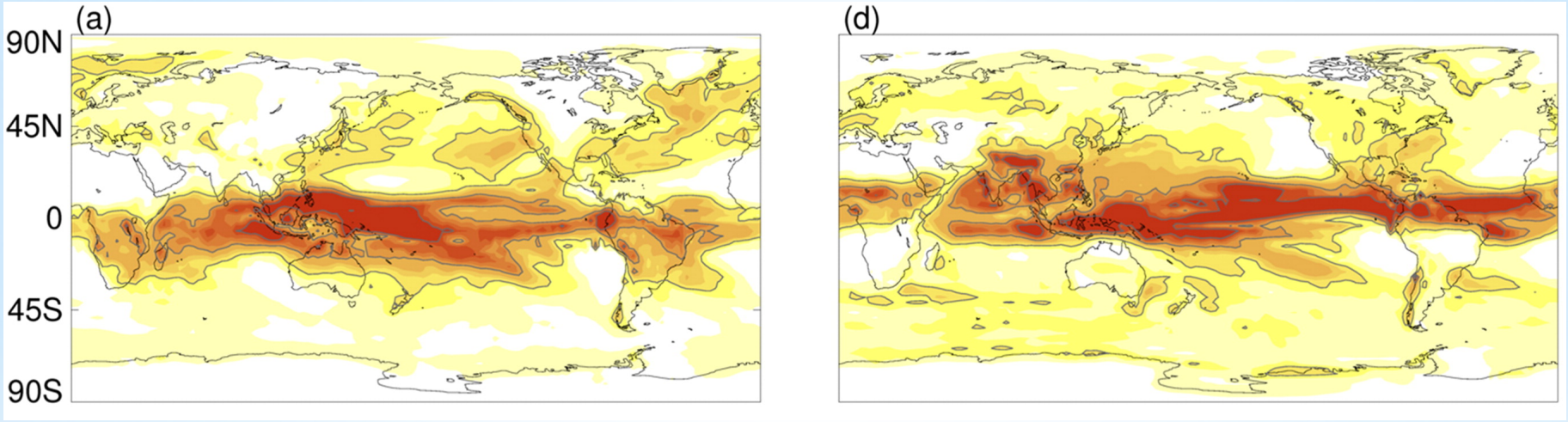
Regional precipitation change is not constrained by large-scale mechanisms

Uncertainty in Model Projections Regional Precipitation Change

Intermodel Standard Deviation of ΔP for 4xCO2 (CMIP5)

Ensemble of CMIP5

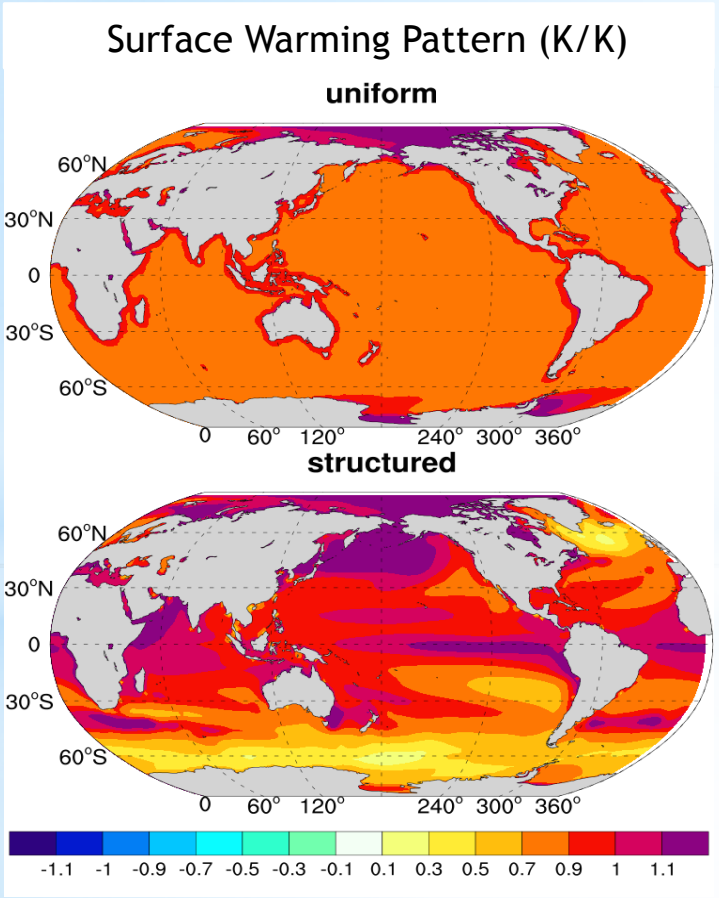
Adjusted for differences in climate sensitivity

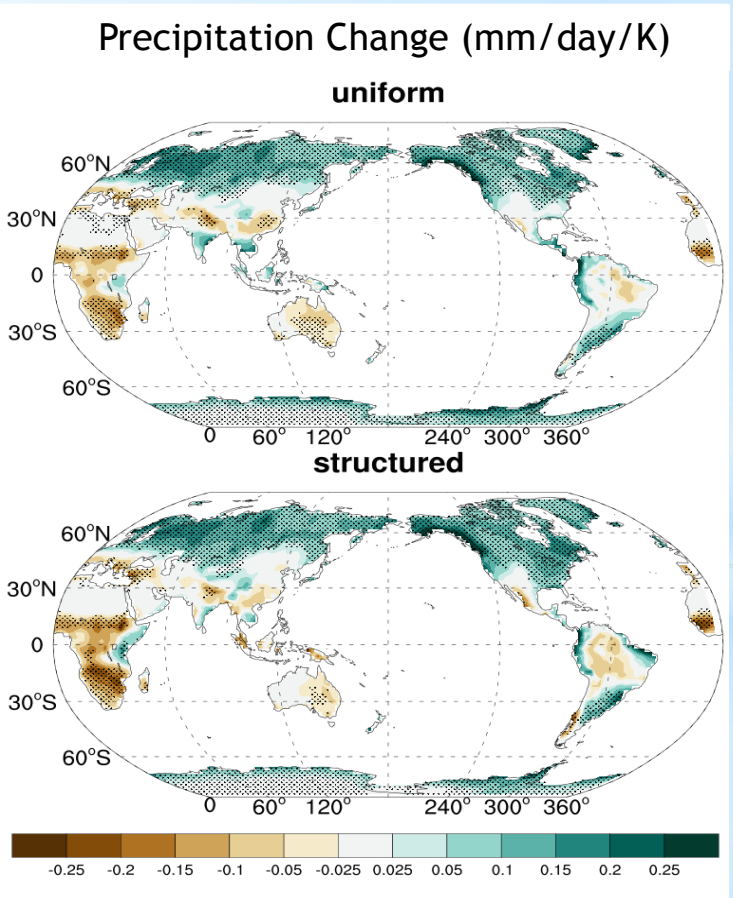


Kent et al. (2015)

Intermodel spread in regional precipitation change is <u>not</u> due to uncertainty in climate sensitivity.

Uncertainty in Model Projections Regional Precipitation Change



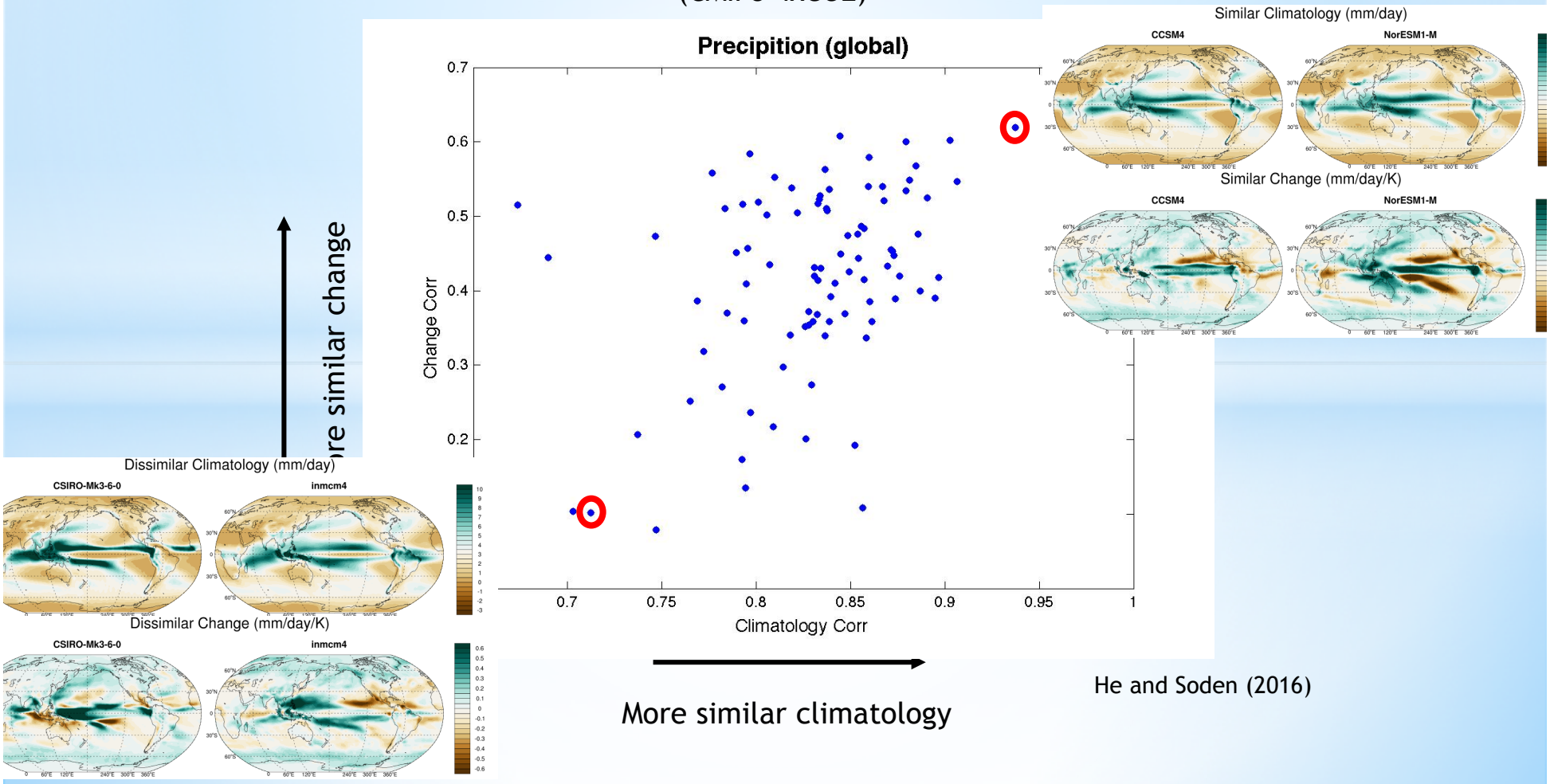


He and Soden (2015)

Projections of land precipitation change are insensitive to the pattern of SST change.

Uncertainty in Model Projections Regional Precipitation Change

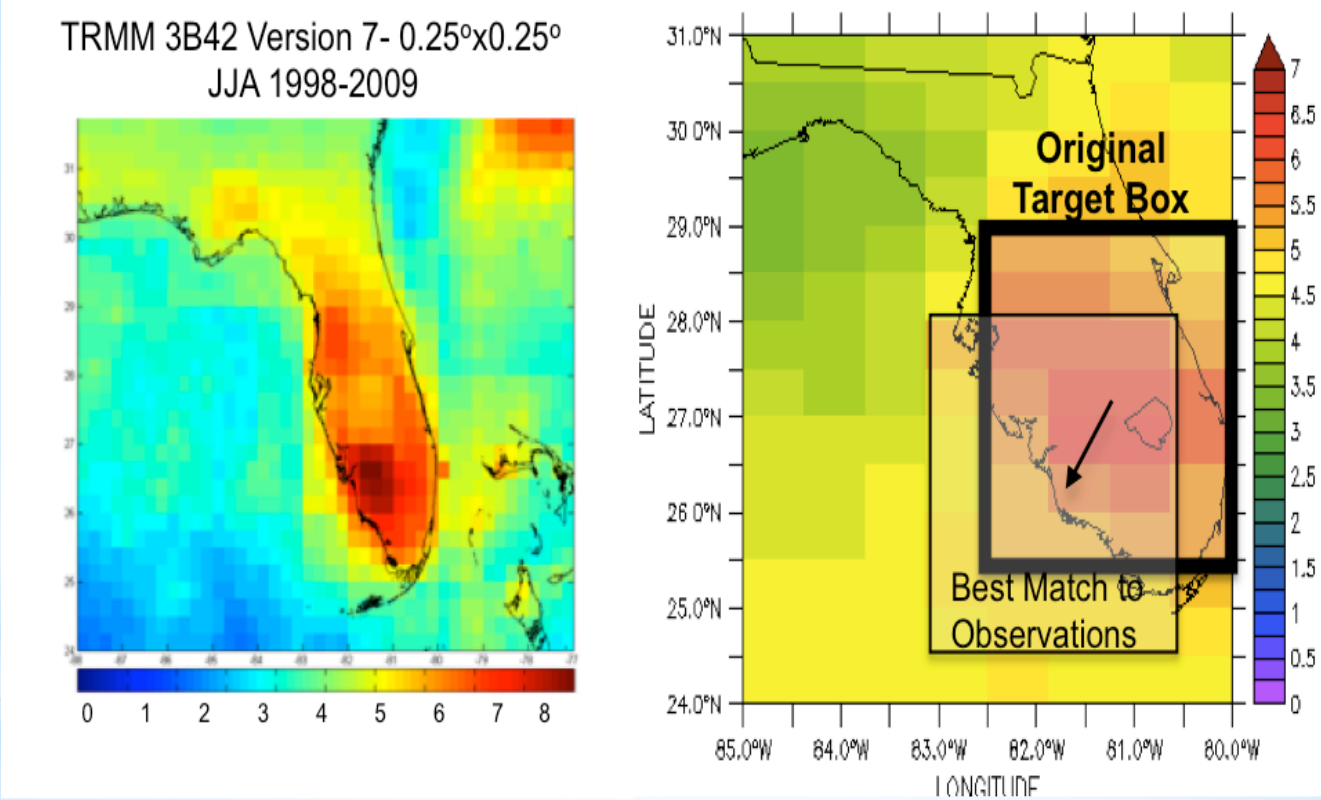
Cross Model Correlation of Precipitation Climatology vs Precipitation Change
(CMIP5 4xCO2)



He and Soden (2016)

Climatological biases strongly affect projection of precipitation change.

Uncertainty in Model Projections Regional Precipitation Change



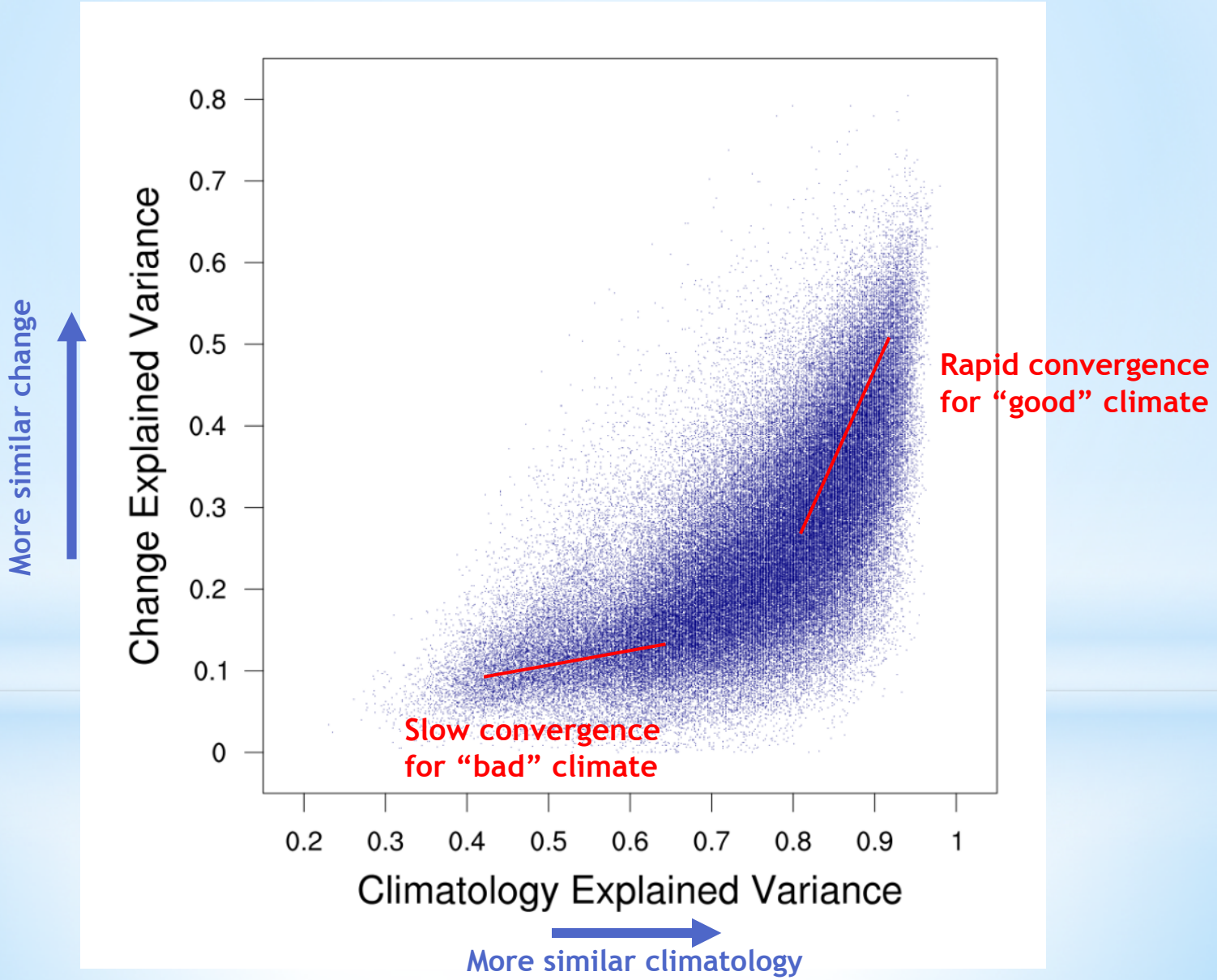
Can we "fix" model biases *ex post facto*?

e.g., use pattern matching algorithms to "remap" model climate

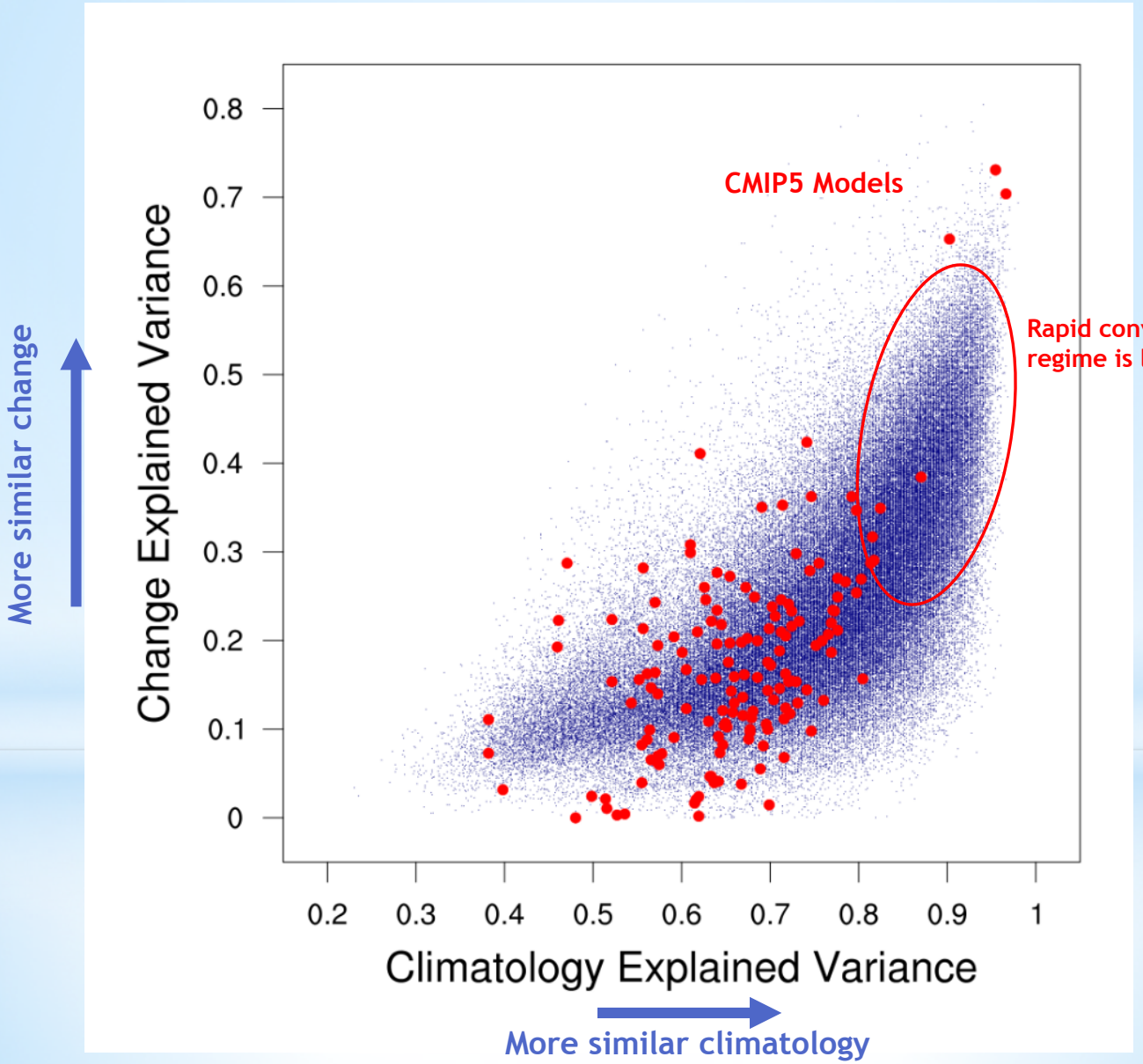
UK Met Office Perturbed Physics Ensemble

- Single model with a range of parameter settings that are varied across a pre-determined range of values elicited from experts
- 500+ different climates and corresponding change projections
- Explore dependence of the change in precipitation on the mean climate using this richer climate space.
  - 250,000+ different climate pairs

Relation of Precipitation Change to Precipitation Climatology



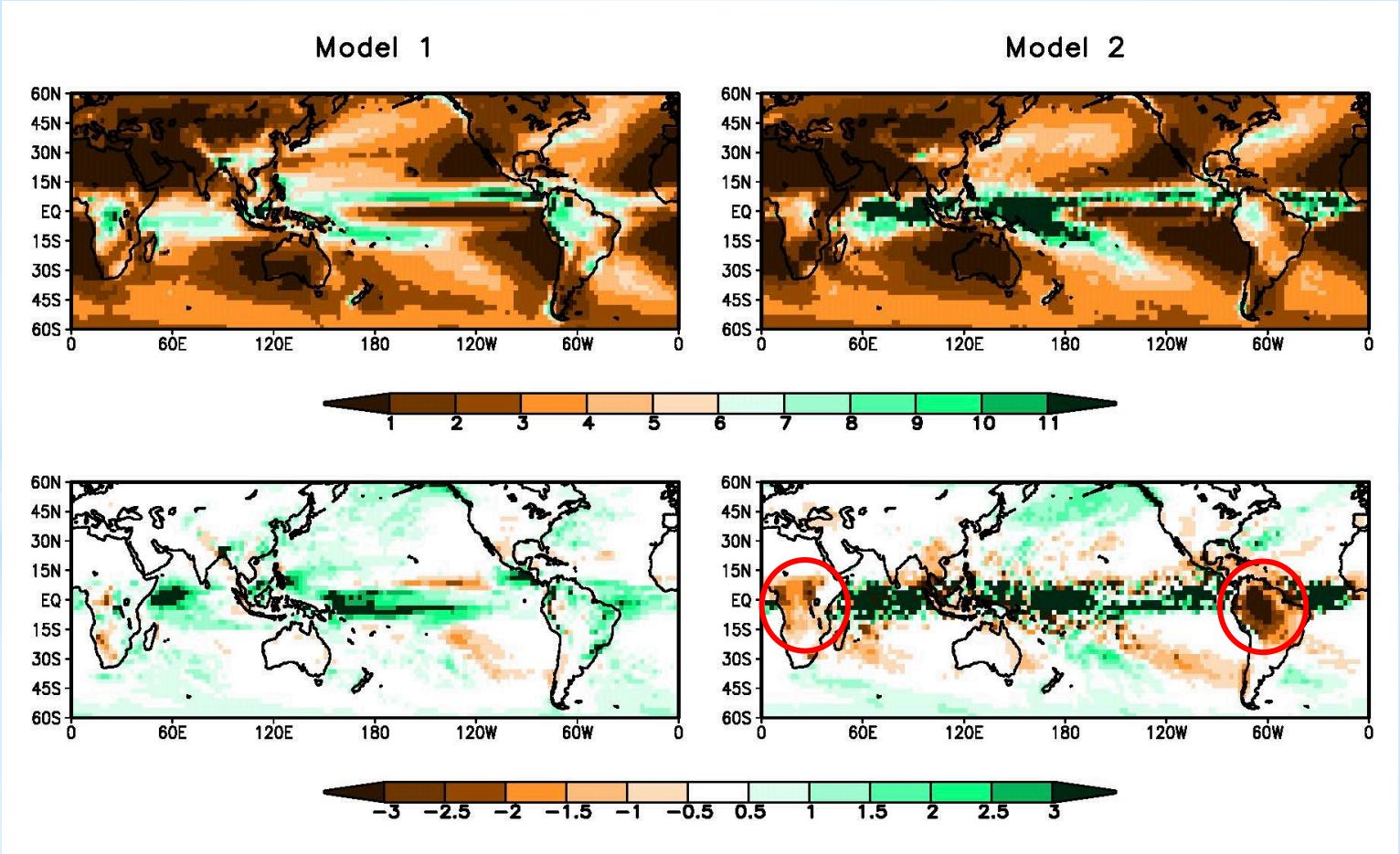
Relation of Precipitation Change to Precipitation Climatology



Where do simulations differ and why?

Climatology

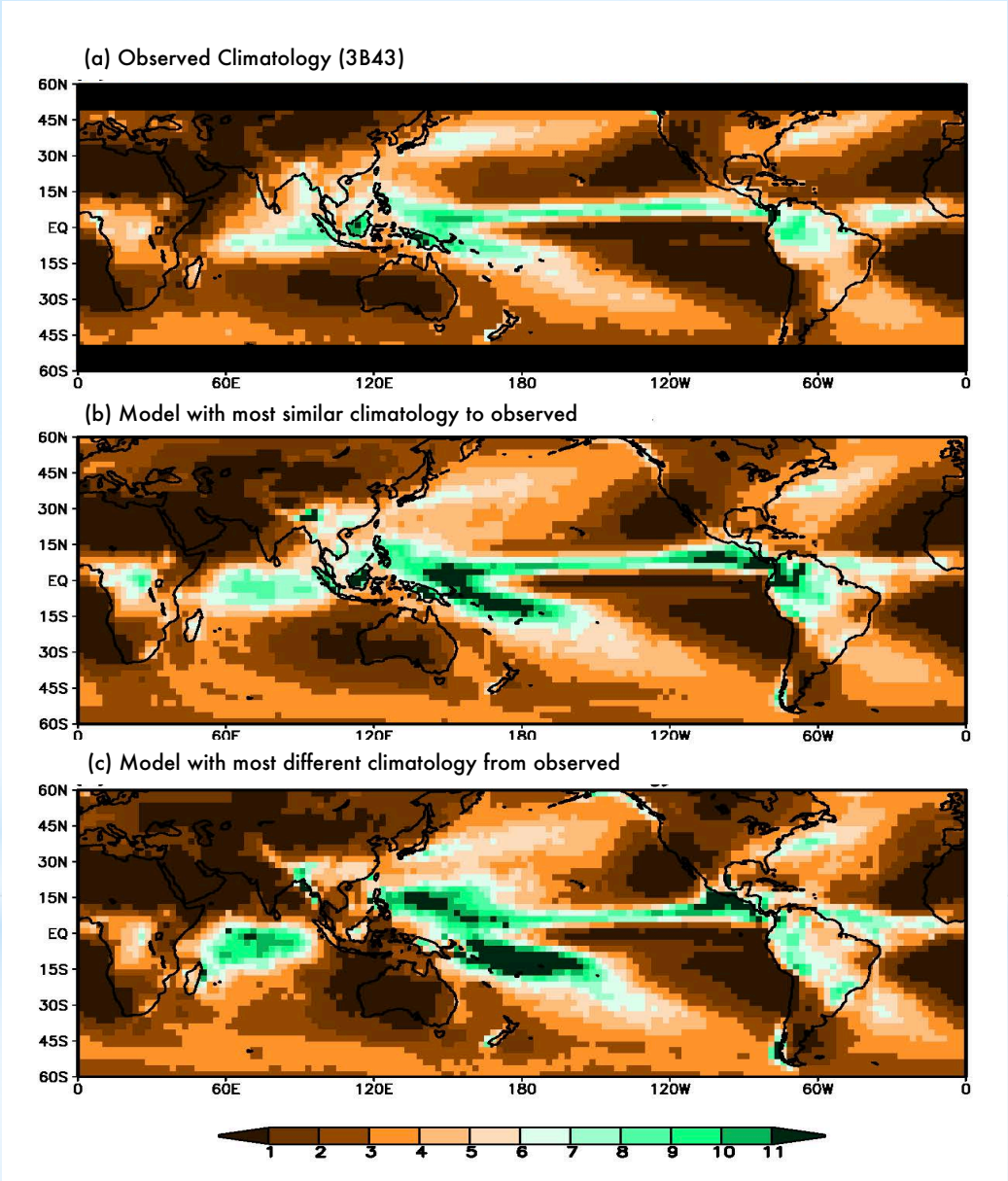
Change



Mean climate is particularly important over low-latitude land regions

Using Observed Climatology as an "Emergent Constraint"

UK Met PPE



r = 0.90

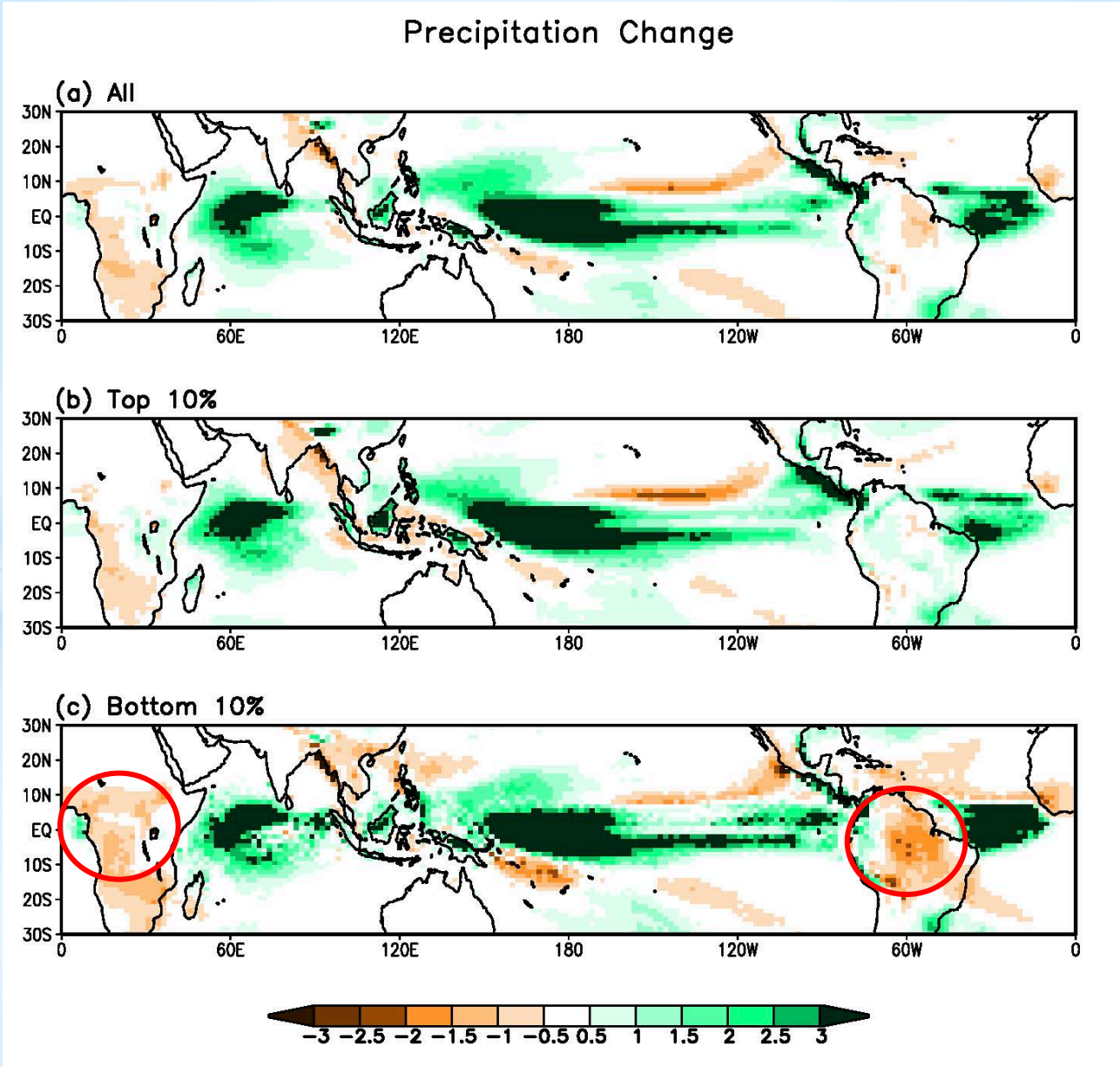
r = 0.65

Using Observed Climatology as an "Emergent Constraint"

All 500+ Models

50 "Best" Models

50 "Worst" Models



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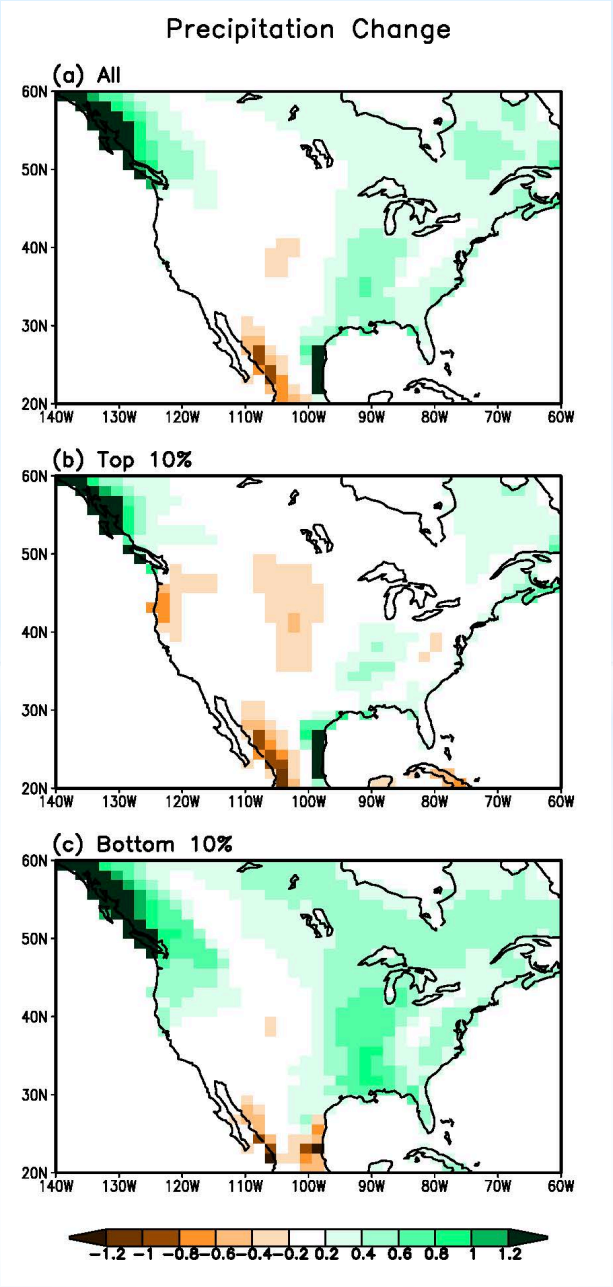
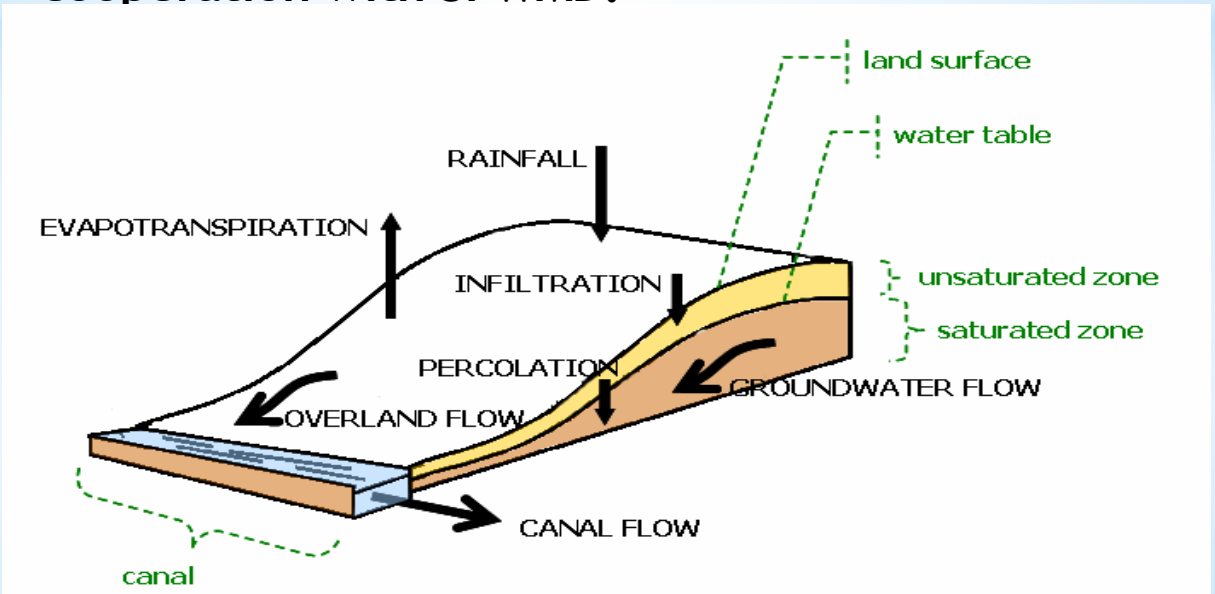


Summary

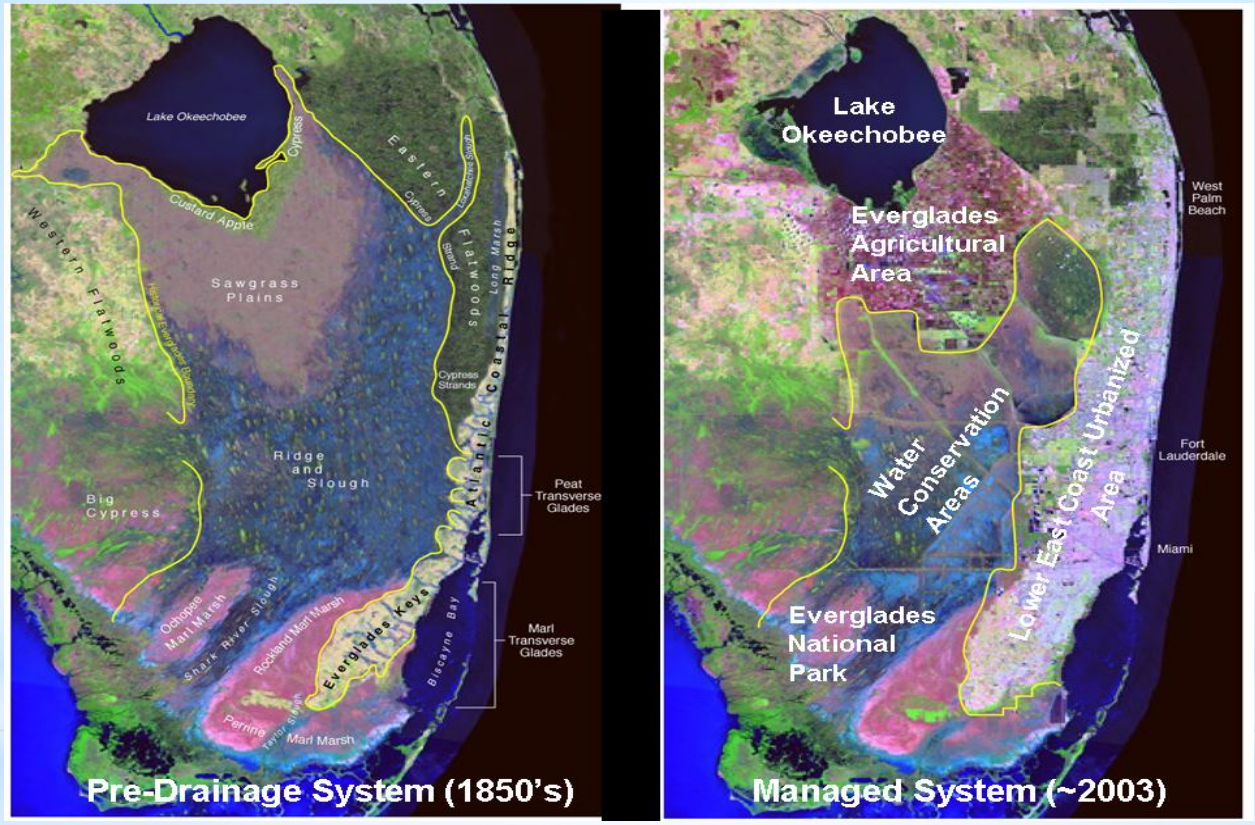
i) The mean climate is important!

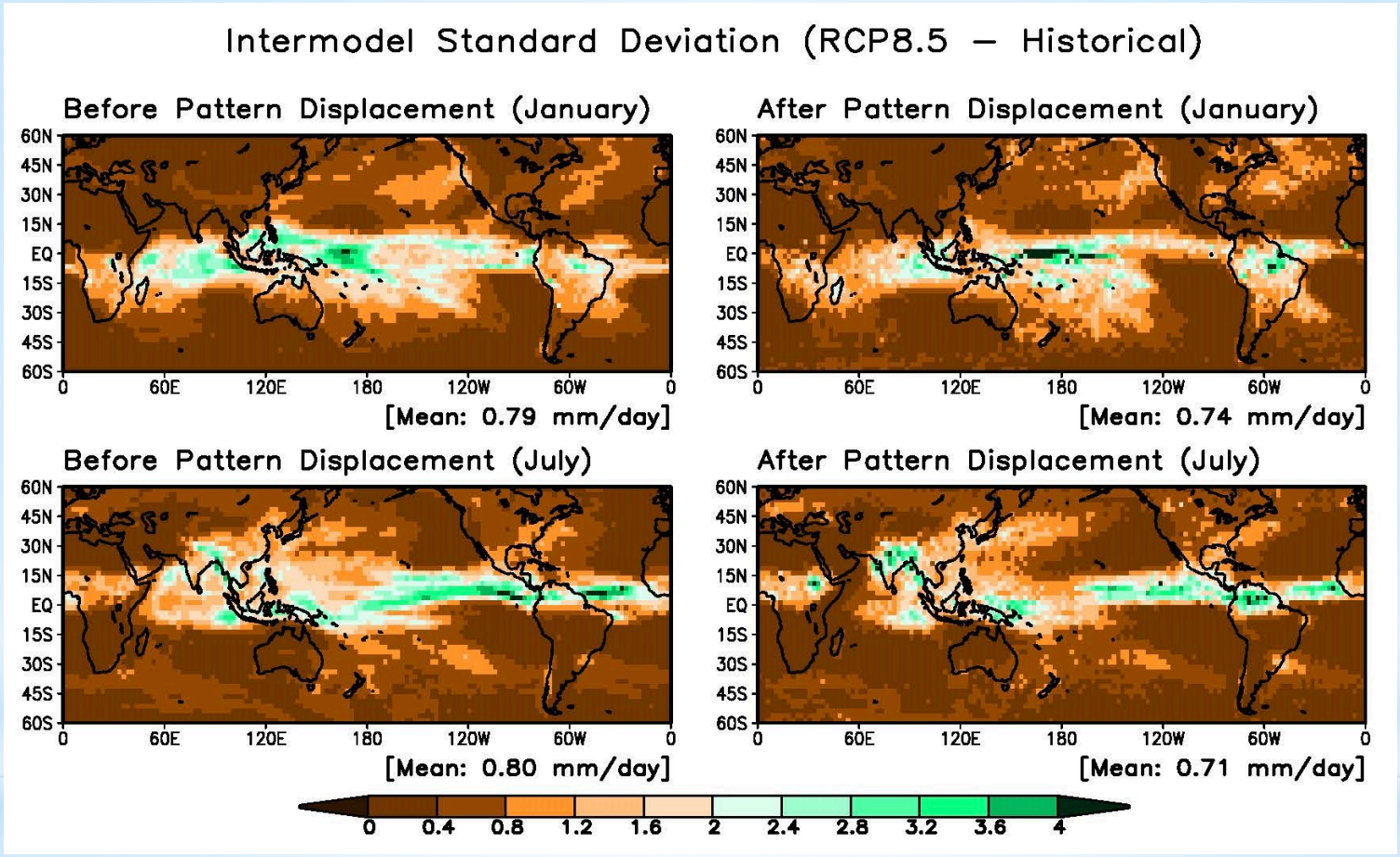
ii) Explore and quantify the role of the mean climate in regional projections of precipitation change.

ii) Begin to incorporate regional projections over Florida with water management planning activities in cooperation with SFWMD.



The Managed Water System of South Florida

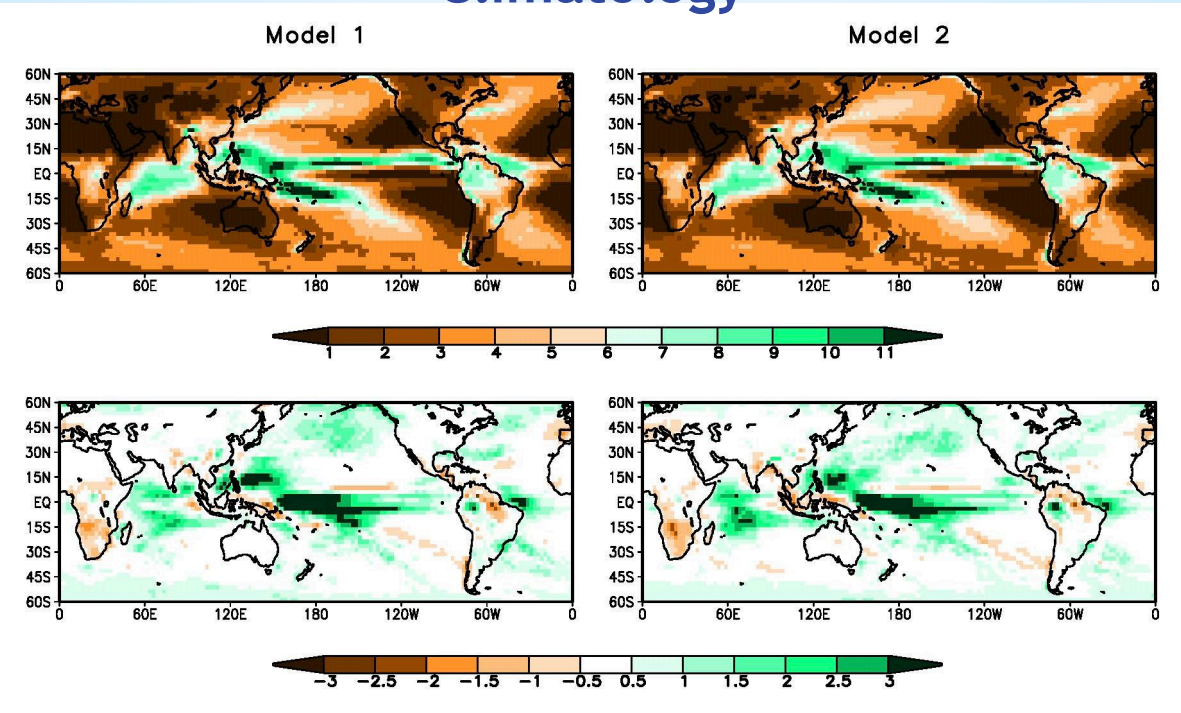



Intermodel Standard Deviation (RCP8.5 – Historical)
Before Pattern Displacement (January)
[Mean: 0.79 mm/day]
After Pattern Displacement (January)
[Mean: 0.74 mm/day]
Before Pattern Displacement (July)
[Mean: 0.80 mm/day]
After Pattern Displacement (July)
[Mean: 0.71 mm/day]
60N
45N
30N
15N
EQ
15S
30S
45S
60S
0
60E
120E
180
120W
60W
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6
4

Relation of Precipitation Change to Precipitation Climatology

Climatology

Change



Models with similar climatology project similar patterns of change